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Research Article

Green Building Techniques: Under The Umbrella of the Climate Framework Agreement

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ABSTRACT

Various green building rating systems have been devised to assess the sustainability levels of buildings, offering a standardized approach to evaluate their environmental impact. However, adapting these existing methods to diverse regions requires addressing additional considerations, such as distinct climatic conditions and regional variations. This study delves into a comprehensive exploration of widely utilized environmental building assessment methodologies, including BREEAM, LEED, SB-Tool, CASBEE, GRIHA, and Eco-housing. A new building environmental assessment scheme tailored to the global landscape is needed due to limitations of existing assessment schemes. A framework based on principal component analysis is introduced to develop this new scheme. PCA applied to a dataset of many responses on building sustainability revealed nine key components, including site selection, environmental impact, building resources and re-use, building services and management, innovative construction techniques, environmental health and safety, mechanical systems, indoor air quality, and economic considerations. A framework for sustainable building development in world is proposed. The study provides insights for designers and developers in developing countries, offering a roadmap for achieving green development. The framework prioritizes key components for a nuanced evaluation of sustainability in building projects, contributing to the global discourse on environmentally responsible construction practices.

1. INTRODUCTION

In the face of escalating environmental challenges and the urgent need for sustainable development, the construction industry has witnessed a paradigm shift towards eco-friendlier practices [1-3]. Green building, also known as sustainable or environmentally responsible construction, encompasses a set of techniques and principles aimed at minimizing the environmental impact of building design, construction, and operation [4-6]. Internationally, the construction sector stands as a major consumer of environmental resources and a significant contributor to environmental pollution. Specifically, the building industry accounts for around 45% of society's material consumption [7-9]. Structures exert influence on the environment, either through the consumption of natural resources or by contributing to environmental degradation [10-12]. Currently, developed nations, hosting only 22% of the global population, are responsible for 70% of the world's energy consumption [13-15]. In comparison to global figures, energy consumption by buildings constituted 30–50% of the energy demand in Canada, the UK, and the USA [16,17]. In contemporary times, the escalating energy demand in buildings within developing nations has led to a swift surge in electricity consumption and subsequent carbon emissions [18]. A green building is characterized as a structure capable of harmonious coexistence with nature, optimizing resource conservation (including energy, land, water, and materials), minimizing pollution across its entire life cycle, and efficiently utilizing space [19,20]. Green buildings fall within the scope of sustainable development, and various rating systems have been established to gauge their sustainability. The primary objective of these assessment tools is to scrutinize diverse facets of sustainable practices throughout the planning, construction, and operational phases of a building. The overarching goal is to integrate best practices that mitigate the adverse environmental impact of the building [21,22]. Biofuels can be included in green buildings through various strategies that leverage these sustainable energy sources. Here are some ways in which biofuels are integrated into

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green building practices: Heating Systems: Bio heat: Biofuels can be used as a renewable alternative in heating systems. Bio heat, a blend of biodiesel and traditional heating oil, is used to generate heat for buildings. Combined Heat and Power (CHP) Systems: Biogas for CHP: Biogas, derived from organic waste, can be used in combined heat and power systems to simultaneously generate electricity and heat for buildings. Electricity Generation: Biopower Plants: Biomass, including certain biofuels, can be used to generate electricity in Biopower plants. These plants burn biomass to produce steam that drives turbines connected to generators. On-Site Energy Production: On-Site Bioenergy Systems: Some green buildings incorporate on-site bioenergy systems, such as anaerobic digesters, to convert organic waste into biogas for electricity or heat. Transportation Fuel: Biodiesel and Bioethanol: Green buildings may encourage the use of biodiesel (derived from vegetable oils or animal fats) or bioethanol (derived from crops like corn or sugarcane) as more sustainable alternatives for transportation fuel. Waste-to-Energy Systems: Bio waste Conversion: Organic waste, including food scraps and agricultural residues, can be processed in anaerobic digesters or other systems to produce biogas for energy [23-25]. Green Building Certification Programs: Recognition of Biofuels in Certifications: Green building certification programs, such as LEED (Leadership in Energy and Environmental Design), may recognize and award points for the use of biofuels in a building's energy systems. Innovative Technologies: Advanced Biofuels: Continued research and development in biofuel technologies may lead to the integration of advanced biofuels, such as algae-based biofuels, in green building energy systems. Local and Sustainable Sourcing: Sourcing Certified Biofuels: Green building initiatives may emphasize the use of biofuels that are certified as sustainably sourced, ensuring that their production aligns with environmental and social responsibility standards. Integrating biofuels into green buildings supports the goal of reducing reliance on fossil fuels, minimizing carbon emissions, and promoting more sustainable and environmentally friendly energy sources. The specific methods used depend on factors such as building size, location, and the availability of biofuel resources in the region. The core objective of green building is to create structures that are energy-efficient, resource-conscious, and environmentally responsible throughout their lifecycle. This holistic approach involves integrating innovative technologies, materials, and design strategies to reduce the ecological footprint associated with buildings.

2. ENERGY-EFFICIENT DESIGN

2.1 Incorporating passive design strategies such as proper orientation, shading, and natural ventilation to optimize energy consumption as shown in Figure 1.

Incorporating passive design strategies involves utilizing architectural and environmental features, such as proper building orientation, shading elements, and natural ventilation, to optimize energy consumption within a structure. By strategically leveraging these passive measures, a building can effectively harness natural elements to regulate temperature, lighting, and airflow, thereby reducing the reliance on active energy-consuming systems. This approach promotes energy efficiency and sustainability in the built environment [26-28].

2.2 Utilizing high-performance insulation, windows, and doors to enhance thermal efficiency.

Utilizing high-performance insulation, windows, and doors is a strategy aimed at enhancing thermal efficiency in buildings. This involves selecting and installing materials that effectively resist heat transfer, minimizing the exchange of heat between the interior and exterior environments. By incorporating these high-quality components, a structure can better retain or repel heat, resulting in improved energy conservation and a more comfortable indoor environment [29-31].

2.3 Implementing energy-efficient HVAC (Heating, Ventilation, and Air Conditioning) systems and incorporating renewable energy sources like solar panels.

Implementing energy-efficient HVAC (Heating, Ventilation, and Air Conditioning) systems is a proactive measure to enhance a building's energy performance. This involves deploying technologically advanced HVAC systems designed to optimize energy usage for heating, cooling, and ventilation. Additionally, incorporating renewable energy sources, such as solar panels, further contributes to sustainability. By harnessing solar power, a building can generate clean energy, reducing reliance on traditional energy grids and lowering its overall environmental impact. This dual strategy aligns with the principles of energy efficiency and renewable resource utilization in the pursuit of environmentally conscious building practices [32-34].

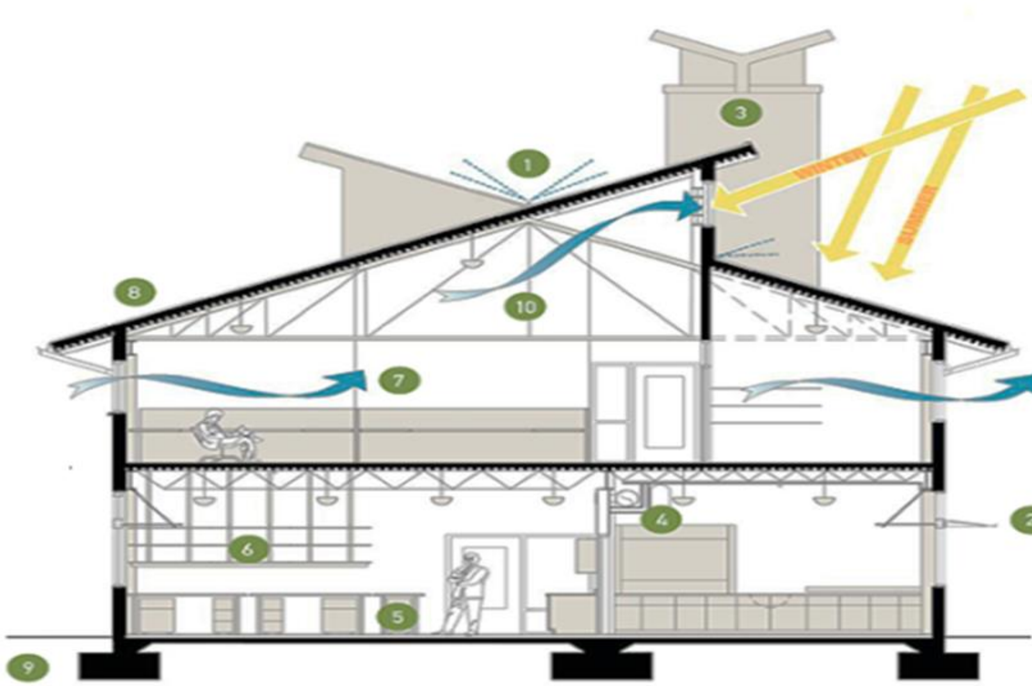

Fig. 1. Home Plans for Energy Efficiency (1- night sky radiant cooling 2- Sunshades 3- Cool lower 4- Heat recovery 5- Heating and Cooling 6- light shelves 7- Naturally top floor 8- Selective Roofing 9- Water detentions 10- lighting control).

3. WATER CONSERVATION

Water conservation refers to the responsible and efficient use, management, and preservation of water resources. It involves adopting practices and strategies to reduce water wastage, promote sustainability, and ensure the long-term availability of freshwater for various purposes, including domestic use, agriculture, industry, and environmental conservation. Water conservation efforts aim to address water scarcity, promote efficient water use, and minimize the environmental impact associated with excessive water consumption. This may include implementing water-saving technologies, adopting mindful behaviors, and implementing policies and practices that prioritize the sustainable use of water resources. Conserving water poses four main challenges as shown in Fig. 2.

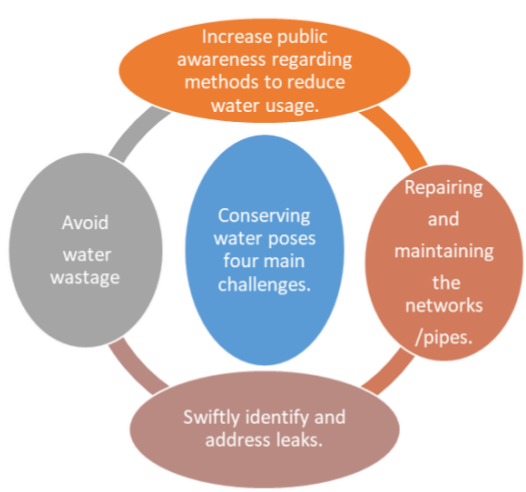

Fig. 2. water conversation.

3.1 Abbreviations and Acronyms.

Installing water-efficient fixtures, faucets, and appliances is a practice focused on minimizing water consumption within a building. This involves incorporating plumbing elements and devices designed to optimize the use of water, reducing waste and promoting efficiency. By adopting such measures, a structure can contribute to water conservation efforts, enhance sustainability, and lower the overall environmental impact associated with water usage in daily activities [35-37].

3.2 Implementing rainwater harvesting systems and greywater recycling to optimize water usage.

Implementing rainwater harvesting systems and greywater recycling involves the collection and reuse of water from natural sources and domestic activities to optimize overall water usage in a building. Rainwater harvesting captures precipitation for various non-potable purposes, while greywater recycling treats and reuses water from activities like laundry and bathing. These practices contribute to sustainable water management, reduce dependence on traditional water sources, and minimize the environmental impact associated with water consumption [38-41].

3.3 Utilizing drought-resistant landscaping and smart irrigation systems.

Employing drought-resistant landscaping and smart irrigation systems represents a sustainable approach to outdoor water management. Drought-resistant landscaping involves selecting plants that thrive in arid conditions, reducing the need for excessive water. Complementing this, smart irrigation systems leverage technology and data to deliver precise and efficient watering, adapting to real-time weather conditions and plant requirements. Together, these practices contribute to water conservation, particularly in regions prone to water scarcity, and promote environmentally conscious landscaping [42-44].

4. SUSTAINABLE MATERIALS.

4.1 Choosing locally sourced, recycled, or rapidly renewable materials to minimize transportation and embodied energy.

Choosing locally sourced, recycled, or rapidly renewable materials is an approach aimed at minimizing the impact of transportation and embodied energy in construction or manufacturing processes. This strategy involves selecting materials that are either available nearby, recycled from existing sources, or derived from rapidly replenished resources. By opting for these alternatives, one can reduce the environmental footprint associated with the transportation of materials and decrease the overall energy consumed during the production and transportation phases. This sustainable choice aligns with efforts to promote eco-friendly practices and mitigate the environmental effects associated with resource extraction and long-distance transportation [45-47].

4.2 Prioritizing low-impact materials with minimal environmental and health hazards.

Prioritizing low-impact materials involves selecting substances that pose minimal environmental and health hazards. This approach emphasizes choosing materials with a reduced negative impact on ecosystems and human well-being. By favoring options that are environmentally friendly and pose fewer health risks, individuals and businesses contribute to sustainable practices and promote a healthier living and working environment. This consideration extends across various industries, from construction and manufacturing to everyday consumer choices, fostering a commitment to responsible and mindful material selection [48-50].

4.3 Adopting cradle-to-cradle design principles, focusing on materials that can be easily recycled or repurposed.

Embracing cradle-to-cradle design principles involves a focus on materials that can be easily recycled or repurposed. This approach centers on creating products with a lifecycle that supports continuous regeneration, where materials are utilized in a closed loop without generating waste. By prioritizing materials that can be efficiently recycled or repurposed, this design philosophy aims to minimize environmental impact and contribute to a more sustainable and circular economy. It encourages a shift away from the traditional linear "cradle-to-grave" model, promoting responsible material choices that align with long-term ecological goals [51-53].

5. WASTE REDUCTION AND RECYCLING

5.1 Implementing construction waste management plans to minimize waste generation.

Implementing plans for construction waste management involves the implementation of strategies to minimize waste generation in construction projects. This approach underscores the significance of meticulous planning and systematic practices aimed at reducing, reusing, and recycling materials to alleviate the environmental impact associated with construction activities [54-56]. Key components of such plans may encompass:

- Source Reduction: Promoting the adoption of efficient construction methods and design practices to minimize the overall volume of generated waste.
- Material Reuse: Identifying opportunities to extend the lifespan of materials from demolition or construction processes, thereby reducing the necessity for new resources.
- Recycling: Establishing systems for the collection, separation, and recycling of materials such as concrete, metal, wood, and other recyclables, diverting them away from landfills.
- Waste Sorting and Segregation: Implementing on-site practices involving the sorting and segregation of waste materials at the source, facilitating easier recycling and minimizing contamination.

5.2 Recycling or repurposing construction and demolition debris.

Recycling or repurposing construction and demolition (C&D) debris involves systematically reusing materials from building sites, thereby diverting waste from landfills and contributing to sustainable resource management [57]. Here's an explanation of these practices with showing in Figure 3:

1- Recycling:

- Material Recovery Facilities (MRFs): Construction and demolition waste is transported to MRFs, where materials like concrete, wood, metal, and other recyclables are sorted and processed.
- Processing: Once separated, materials are processed to remove contaminants and prepare them for reuse.
- Reuse in Construction: Recycled materials, such as crushed concrete or reclaimed wood, can be reintegrated into new construction projects, reducing the need for virgin resources.

2- Repurposing:

- Identification of Salvageable Items: Before demolition, efforts are made to identify and salvage materials that can be repurposed, such as doors, windows, fixtures, or structural elements.
- Deconstruction Practices: Rather than demolition, deconstruction involves carefully dismantling structures to salvage reusable materials. This method is more labor-intensive but yields higher-quality materials for reuse.
- Donation or Sale: Salvaged items can be donated to charities or sold for reuse in other construction projects, providing cost-effective alternatives for builders and preserving valuable resources.

3- Benefits:

- Waste Reduction: Recycling or repurposing reduces the amount of construction and demolition waste sent to landfills, mitigating environmental impact.
- Conservation of Resources: By reusing materials, there is a reduced demand for new resources, contributing to resource conservation.
- Energy Savings: Recycling materials often requires less energy than producing new ones, leading to energy savings and a lower carbon footprint.
- Economic Opportunities: The sale of salvaged materials and the creation of recycling jobs contribute to economic opportunities in the waste management sector.

4- Challenges:

- Logistics: Transporting and processing C&D debris for recycling or repurposing can be logistically challenging.
- Contamination: Contamination of materials with hazardous substances or non-recyclable items may hinder effective recycling efforts.

- Awareness: Ensuring that construction industry professionals are aware of and committed to recycling and repurposing practices is essential for success.

By incorporating recycling and repurposing into construction and demolition practices, the industry can move towards more sustainable and environmentally friendly approaches, promoting circular economy principles [58].

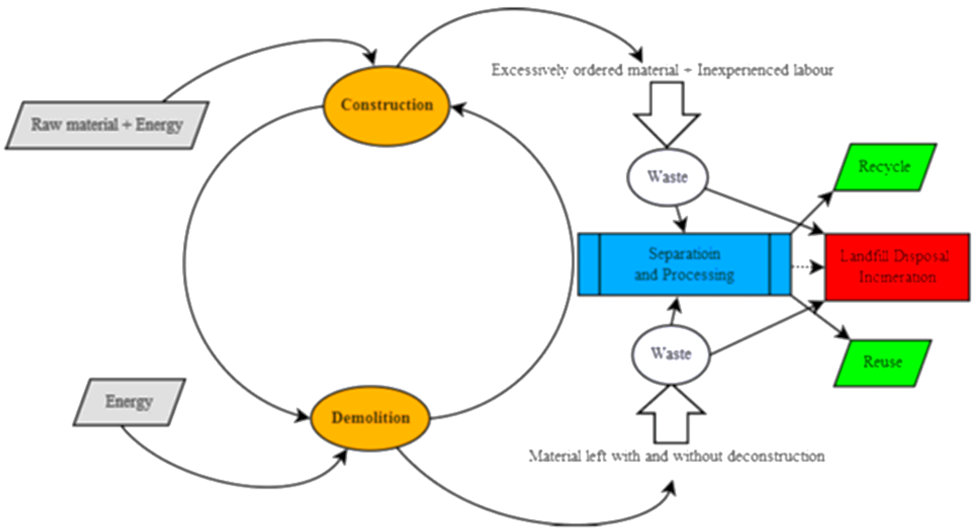

Fig. 3. Waste Reduction and Recycling [59].

5.3 Encouraging the use of modular construction and prefabrication to reduce material waste on-site.

Promoting the utilization of modular construction and prefabrication serves as a strategy designed to minimize material waste in construction endeavors. Here's an elucidation of how these methodologies contribute to waste reduction. Modular Construction, Off-Site Assembly: In modular construction, building components are assembled off-site within controlled factory environments. Precision and Efficiency: The precision in manufacturing components diminishes errors, consequently minimizing material waste during production. Just-in-Time Delivery: Modules are transported to the construction site precisely when needed, reducing the likelihood of damage and on-site material storage. Prefabrication, Factory-Based Production: Prefabrication involves the production of building elements, such as walls, floors, or roofs, within a factory setting. Customization and Efficiency: The prefabrication process allows for customization, facilitating the efficient use of materials and minimizing waste [60-62].

6. GREEN ROOF AND WALLS.

6.1 Installing green roofs and walls to enhance insulation, reduce storm water runoff, and provide additional green space.

Installing green roofs and walls involves incorporating vegetation on building surfaces to achieve multiple environmental benefits. The primary purposes include enhancing insulation, reducing storm water runoff, and creating additional green spaces [63-65].

- Enhanced Insulation: Green roofs and walls act as natural insulators, regulating indoor temperatures by providing an additional layer that helps keep buildings cooler in the summer and warmer in the winter. This can contribute to energy efficiency and reduced reliance on heating or cooling systems.
- Reduced Stormwater Runoff: The vegetation on green roofs and walls absorbs rainwater, reducing the volume of stormwater runoff. This helps alleviate the strain on urban drainage systems, preventing issues such as flooding and soil erosion. The absorbed water is gradually released or evaporated, contributing to sustainable water management.

- Additional Green Space: Green roofs and walls contribute to the expansion of green spaces in urban environments. This not only enhances aesthetics but also provides areas for recreation and relaxation. The presence of vegetation in densely populated areas can improve air quality and overall well-being.

In summary, the installation of green roofs and walls is a multifaceted approach that goes beyond traditional building practices. It serves to enhance energy efficiency, mitigate the impact of storm water runoff on urban infrastructure, and introduce valuable green spaces to urban landscapes.

6.2 Promoting biodiversity and improving air quality through the integration of vegetation into building structures.

Integrating vegetation into building structures not only enhances the aesthetic appeal of urban spaces but also plays a crucial role in promoting biodiversity, improving air quality, regulating temperatures, and supporting overall environmental sustainability. This approach reflects a holistic understanding of the built environment's impact on the natural world and seeks to create more harmonious and resilient urban ecosystems [66-68].

7. INDOOR ENVIRONMENTAL QUALITY.

7.1 Ensuring proper ventilation and air quality using advanced systems.

Ensuring proper ventilation and air quality using advanced systems involves employing sophisticated technologies and strategies to maintain a healthy and comfortable indoor environment [69-71]. Here's an explanation:

1- Ventilation Systems:

Mechanical Ventilation: Advanced ventilation systems use mechanical components, such as fans and ductwork, to circulate and exchange air within a building. This helps in preventing the buildup of indoor pollutants and ensures a constant supply of fresh outdoor air.

Heat Recovery Ventilation (HRV) and Energy Recovery Ventilation (ERV): These systems recover and exchange heat between incoming and outgoing air, enhancing energy efficiency while maintaining optimal air quality.

2- Air Quality Monitoring:

Sensors and Monitoring Devices: Advanced systems often incorporate sensors to measure indoor air quality parameters such as particulate matter, carbon dioxide (CO2), humidity, and volatile organic compounds (VOCs). Real-time monitoring allows for immediate responses to fluctuations in air quality.

3- Filtration Systems:

High-Efficiency Particulate Air (HEPA) Filters: These filters trap microscopic particles, including dust, pollen, and allergens, enhancing air quality by reducing the presence of airborne pollutants.

Activated Carbon Filters: These filters are effective in removing odors, gases, and VOCs, contributing to improved indoor air quality.

4- Humidity Control:

Humidification and Dehumidification Systems: Advanced HVAC (Heating, Ventilation, and Air Conditioning) systems include mechanisms to control humidity levels, preventing issues such as mold growth and optimizing occupant comfort.

5- Smart Building Technologies:

Building Automation Systems (BAS): Integration with BAS allows for the centralized control and monitoring of various building systems, including ventilation and air quality. Automated responses can be programmed based on pre-defined criteria.

Internet of Things (IoT): IoT-enabled devices and sensors can provide data on air quality parameters and enable remote monitoring and control, allowing for proactive management of indoor environments.

6- Energy Efficiency Considerations:

Energy-Efficient Ventilation: Advanced systems prioritize energy efficiency through features like demand-controlled ventilation, which adjusts airflow based on occupancy levels, optimizing energy use without compromising air quality.

Ensuring proper ventilation and air quality through advanced systems is crucial for maintaining a healthy and comfortable indoor environment, particularly in spaces where occupants spend significant amounts of time. These systems not only enhance health and well-being but also contribute to energy efficiency and environmental sustainability.

7.2 Selecting low-emission materials and finishes to enhance indoor air quality.

Selecting low-emission materials and finishes is a strategy aimed at improving indoor air quality by minimizing the release of harmful pollutants and volatile organic compounds (VOCs) from building materials [72-74]. Here's an explanation of how this practice contributes to healthier indoor environments:

1- Low-VOC Materials:

Paints and Coatings: Choosing paints and coatings with low or no VOC content helps prevent the release of harmful chemicals into the indoor air. Water-based paints, for example, often have lower VOC levels compared to oil-based alternatives.

Adhesives and Sealants: Low-VOC adhesives and sealants are used in construction to reduce off-gassing and the emission of harmful substances. This is particularly important for indoor air quality during and after construction or renovation.

2- Low-Emission Flooring:

- Carpeting: Selecting carpets with low VOC emissions or those certified as environmentally friendly can contribute to better indoor air quality. Similarly, using low-emission adhesives during carpet installation helps minimize off-gassing.
- Hard Flooring Materials: Materials like hardwood, bamboo, or ceramic tiles, which emit fewer harmful substances, are preferred for flooring to enhance indoor air quality.

3- Eco-Friendly Insulation:

- Insulation Materials: Choosing insulation materials with low emissions, such as natural fibers or recycled content, can help maintain better indoor air quality. Fiberglass and foam insulation materials may emit VOCs during installation but should dissipate over time.

4- Formaldehyde-Free Wood Products:

Composite Wood Products: Wood products like particleboard, plywood, and MDF can release formaldehyde, a common indoor air pollutant. Opting for products labeled as formaldehyde-free or with low-emission standards, such as CARB Phase 2 compliance, reduces exposure.

5- Green Label-Certified Products:

Certifications: Look for products with certifications such as Green Guard or Green Seal, which indicate that they meet specific indoor air quality and emission standards. These certifications provide assurance that the materials have undergone testing for low emissions.

6- Proper Ventilation:

Ventilation Systems: While selecting low-emission materials is crucial, ensuring effective ventilation is equally important. Proper ventilation systems help to dilute and remove indoor air pollutants, creating a healthier indoor environment.

7.3 Incorporating natural light and views to improve occupant well-being and productivity.

Incorporating natural light and views into building design is not only aesthetically pleasing but also essential for occupant well-being and productivity. These design considerations align with a holistic approach to creating healthier and more sustainable built environments [75].

8. LIFE CYCLE ASSESSMENT.

1.1 Conducting a comprehensive life cycle analysis to evaluate the environmental impact of a building from construction to demolition.

Conducting a comprehensive life cycle analysis involves assessing the environmental impact of a building across its entire lifespan, from construction through to demolition. This analysis considers various factors, including resource extraction, material production, construction processes, energy consumption, operational use, maintenance, and eventual demolition or disposal. By evaluating each phase, the analysis provides a holistic understanding of the building's environmental footprint, guiding sustainable practices and decision-making to minimize its overall impact on the environment. This approach promotes informed choices in design, construction methods, and materials to enhance the building's overall sustainability [76-78].

1.2 Considering long-term factors such as maintenance, energy consumption, and end-of-life disposal.

Considering long-term factors such as maintenance, energy consumption, and end-of-life disposal involves adopting a holistic approach to building design and management [79-88]. It means:

1- Maintenance:

- **Durability:** Choosing materials and construction methods that are durable and require minimal maintenance over time.
- **Life Cycle Cost Analysis:** Evaluating the economic impact of maintenance needs throughout the building's lifespan.

2- Energy Consumption:

- **Energy-Efficient Design:** Implementing design strategies that minimize the building's operational energy consumption.
- Renewable Energy: Integrating renewable energy sources to reduce reliance on non-renewable energy over the long term.

3- End-of-Life Disposal:

- Material Selection: Choosing materials that are recyclable or reusable to facilitate responsible disposal practices.
- Demolition Planning: Developing plans for responsible demolition or deconstruction to minimize waste and promote material recycling.

Considering these long-term factors ensures that a building is not only functional and aesthetically pleasing but also sustainable and environmentally responsible throughout its entire lifecycle. This approach aligns with principles of green building and contributes to the overall resilience and longevity of the built environment.

9. CONCLUSION AND RECOMMENDATION.

The adoption of green building techniques represents a proactive response to the environmental challenges facing the planet. By integrating these sustainable practices, the construction industry can contribute significantly to the creation of healthier, more energy-efficient, and environmentally responsible built environments. As we celebrate the 1-year milestone, it is crucial to continue advancing these techniques and fostering a culture of sustainability within the construction industry for a greener and more resilient future. By aligning green building techniques with the overarching goals of the Climate Framework Agreement, we can create a more sustainable and resilient built environment. This integration not only addresses environmental concerns but also contributes to global efforts to mitigate climate change and build a more sustainable future for all.

Recommendation

1. Integration of Climate-Responsive Design:

Emphasize the alignment of green building techniques with the goals and guidelines outlined in the Climate Framework Agreement. Integrate climate-responsive design strategies to adapt to changing environmental conditions and contribute to climate resilience.

2. Carbon-Neutral Construction Practices:

Prioritize techniques that aim for carbon neutrality, focusing on minimizing carbon emissions throughout the construction lifecycle. Explore innovative materials and technologies that help sequester or offset carbon, aligning with the carbon reduction targets set by the Climate Framework Agreement.

3. Renewable Energy Integration:

Strengthen the emphasis on renewable energy sources within green building techniques, aligning with the Climate Framework Agreement's objectives for clean and sustainable energy adoption. Highlight the role of on-site renewable energy generation, such as solar panels or wind turbines, in reducing reliance on fossil fuels.

4. Resilient Infrastructure Planning:

Recommend green building techniques that contribute to the creation of resilient and adaptive infrastructure in the face of climate change. Advocate for designs that consider rising sea levels, extreme weather events, and other climate-related challenges.

5. Ecosystem Services and Biodiversity Preservation:

Stress the importance of green building techniques in preserving ecosystem services and promoting biodiversity, addressing goals outlined in the Climate Framework Agreement. Discuss the role of green roofs, sustainable landscaping, and habitat preservation in supporting ecological balance.

6. Circular Economy Principles:

Embrace circular economy principles within green building practices, aligning with the Climate Framework Agreement's emphasis on resource efficiency and waste reduction. Encourage the reuse, recycling, and repurposing of materials to minimize the environmental impact of construction projects.

7. Community Engagement and Social Equity:

Recommend green building practices that foster community engagement and social equity, aligning with the Climate Framework Agreement's commitment to just and inclusive climate action. Highlight projects that prioritize affordable housing, community amenities, and accessibility for all.

8. Monitoring and Reporting:

Advocate for robust monitoring and reporting mechanisms to track the environmental performance of green building projects in line with the transparency goals of the Climate Framework Agreement. Encourage stakeholders to regularly assess and report on energy efficiency, carbon emissions, and other key sustainability metrics.

Conflicts Of Interest

None

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References

[1] S. D. Datta, B. A. Tayeh, I. Y. Hakeem, and Y. I. Abu Aisheh, “Benefits and Barriers of Implementing Building Information Modeling Techniques for Sustainable Practices in the Construction Industry—A Comprehensive Review,” Sustain., vol. 15, no. 16, 2023, doi: 10.3390/su151612466.

[2] N. M. Saleh, A. M. Saleh, and R. A. Hasan, “The Renewable , Sustainable , and Clean Energy in Iraq Between Reality and Ambition According to the Paris Agreement on Climate Change,” pp. 1–8, 2022.

[3] I. Makarova, P. Buyvol, E. Mukhametdinov, and A. Boyko, “The Construction of Seaports in the Arctic: Prospects and Environmental Consequences,” J. Mar. Sci. Eng., vol. 11, no. 10, 2023, doi: 10.3390/jmse11101902.

[4] A. F. Abdelfattah, “Sustainable development practices and its effect on green buildings,” IOP Conf. Ser. Earth Environ. Sci., vol. 410, no. 1, 2020, doi: 10.1088/1755-1315/410/1/012065.

[5] C. C. Bungau, T. Bungau, I. F. Prada, and M. F. Prada, “Green Buildings as a Necessity for Sustainable Environment Development: Dilemmas and Challenges,” Sustain., vol. 14, no. 20, pp. 1–34, 2022, doi: 10.3390/su142013121.

[6] S. M. Khoshnava, R. Rostami, R. M. Zin, D. Štreimikienė, A. Mardani, and M. Ismail, “The role of green building materials in reducing environmental and human health impacts,” Int. J. Environ. Res. Public Health, vol. 17, no. 7, 2020, doi: 10.3390/ijerph17072589.

[7] G. S. Vyas and K. N. Jha, “Identification of green building attributes for the development of an assessment tool: a case study in India,” Civ. Eng. Environ. Syst., vol. 33, no. 4, pp. 313–334, 2016, doi: 10.1080/10286608.2016.1247832.

[8] M. A. B. Omer and T. Noguchi, “A conceptual framework for understanding the contribution of building materials in the achievement of Sustainable Development Goals (SDGs),” Sustain. Cities Soc., vol. 52, p. 101869, 2020, doi: https://doi.org/10.1016/j.scs.2019.101869.

[9] L. Lima, E. Trindade, L. Alencar, M. Alencar, and L. Silva, “Sustainability in the construction industry: A systematic review of the literature,” J. Clean. Prod., vol. 289, p. 125730, 2021, doi: https://doi.org/10.1016/j.jclepro.2020.125730.

[10] R. Lanre Ibrahim, K. Bello Ajide, M. Usman, and R. Kousar, “Heterogeneous effects of renewable energy and structural change on environmental pollution in Africa: Do natural resources and environmental technologies reduce pressure on the environment?,” Renew. Energy, vol. 200, pp. 244–256, 2022, doi: https://doi.org/10.1016/j.renene.2022.09.134.

[11] T. S. Adebayo, S. Saint Akadiri, A. T. Adedapo, and N. Usman, “Does interaction between technological innovation and natural resource rent impact environmental degradation in newly industrialized countries? New evidence from method of moments quantile regression,” Environ. Sci. Pollut. Res., vol. 29, no. 2, pp. 3162–3169, 2022, doi: 10.1007/s11356-021-17631-y.

[12] W. Shittu, F. F. Adedoyin, M. I. Shah, and H. O. Musibau, “An investigation of the nexus between natural resources, environmental performance, energy security and environmental degradation: Evidence from Asia,” Resour. Policy, vol. 73, p. 102227, 2021, doi: https://doi.org/10.1016/j.resourpol.2021.102227.

[13] P. Glavič, “Evolution and current challenges of sustainable consumption and production,” Sustain., vol. 13, no. 16, 2021, doi: 10.3390/su13169379.

[14] A. Rauf et al., “Does sustainable growth, energy consumption and environment challenges matter for Belt and Road Initiative feat? A novel empirical investigation,” J. Clean. Prod., vol. 262, p. 121344, 2020, doi: https://doi.org/10.1016/j.jclepro.2020.121344.

[15] O. Bamisile et al., “Electrification and renewable energy nexus in developing countries; an overarching analysis of hydrogen production and electric vehicles integrality in renewable energy penetration,” Energy Convers. Manag., vol. 236, p. 114023, 2021, doi: https://doi.org/10.1016/j.enconman.2021.114023.

[16] A. Kalua, “Urban residential building energy consumption by end-use in Malawi,” Buildings, vol. 10, no. 2, pp. 1–15, 2020, doi: 10.3390/buildings10020031.

[17] Y. Himeur, A. Alsalemi, F. Bensaali, and A. Amira, “Building power consumption datasets: Survey, taxonomy and future directions,” Energy Build., vol. 227, p. 110404, 2020, doi: https://doi.org/10.1016/j.enbuild.2020.110404.

[18] H. A. Nizam et al., “Achieving environmental sustainability through information technology: ‘Digital Pakistan’ initiative for green development,” Environ. Sci. Pollut. Res., vol. 27, no. 9, pp. 10011–10026, 2020, doi: 10.1007/s11356-020-07683-x.

[19] X. Wang et al., “A review of carbon footprint reduction of green building technologies in China,” Prog. Energy, vol. 5, no. 3, p. 32002, Jul. 2023, doi: 10.1088/2516-1083/acdd4b.

[20] S. L. Boca Santa, J. M. P. Ribeiro, G. Mazon, J. Schneider, R. L. Barcelos, and J. B. S. O. de Andrade Guerra, “A Green Airport model: Proposition based on social and environmental management systems,” Sustain. Cities Soc., vol. 59, p. 102160, 2020, doi: https://doi.org/10.1016/j.scs.2020.102160.

[21] T. Sartori, R. Drogemuller, S. Omrani, and F. Lamari, “A schematic framework for Life Cycle Assessment (LCA) and Green Building Rating System (GBRS),” J. Build. Eng., vol. 38, p. 102180, 2021, doi: https://doi.org/10.1016/j.jobe.2021.102180.

[22] A. Tleuken, G. Tokazhanov, M. Guney, A. Turkyilmaz, and F. Karaca, Readiness assessment of green building certification systems for residential buildings during pandemics, vol. 13, no. 2. 2021. doi: 10.3390/su13020460.

[23] A. M. Saleh and N. M. Saleh, “Production of Biofuels from Biomass as an Approach Towards Sustainable Development : A Short Review,” vol. 3, no. 1, pp. 9–21, 2022.

[24] A. M. Saleh et al., “Production of First and Second-Generation Biodiesel for Diesel Engine Operation : A Review,” vol. 5, pp. 8–23, 2023.
[25] L. López, J. Bocanegra, and D. Malagón-Romero, “Production of biodiesel from waste cooking oil by transesterification,” Ing. y Univ., vol. 19, no. 1, pp. 155–172, 2015, doi: 10.11144/javeriana.iyu19-1.odba.
[26] Y. Elaouzy and A. El Fadar, “Energy, economic and environmental benefits of integrating passive design strategies into buildings: A review,” Renew. Sustain. Energy Rev., vol. 167, p. 112828, 2022, doi: https://doi.org/10.1016/j.rser.2022.112828.
[27] A. Balali, A. Yunusa-Kaltungo, and R. Edwards, “A systematic review of passive energy consumption optimisation strategy selection for buildings through multiple criteria decision-making techniques,” Renew. Sustain. Energy Rev., vol. 171, p. 113013, 2023, doi: https://doi.org/10.1016/j.rser.2022.113013.
[28] E. Mushtaha et al., “The impact of passive design strategies on cooling loads of buildings in temperate climate,” Case Stud. Therm. Eng., vol. 28, p. 101588, 2021, doi: https://doi.org/10.1016/j.csite.2021.101588.
[29] M. J. Abden, Z. Tao, M. A. Alim, Z. Pan, L. George, and R. Wuhrer, “Combined use of phase change material and thermal insulation to improve energy efficiency of residential buildings,” J. Energy Storage, vol. 56, p. 105880, 2022, doi: https://doi.org/10.1016/j.est.2022.105880.
[30] J. Paulos and U. Berardi, “Optimizing the thermal performance of window frames through aerogel-enhancements,” Appl. Energy, vol. 266, p. 114776, 2020, doi: https://doi.org/10.1016/j.apenergy.2020.114776.
[31] E. M. H. Ismaeil and A. E. E. Sobaih, “High-Performance Glazing for Enhancing Sustainable Environment in Arid Region’s Healthcare Projects,” Buildings, vol. 13, no. 5, 2023, doi: 10.3390/buildings13051243.
[32] E. K. Simpeh, J.-P. G. Pillay, R. Ndihokubwayo, and D. J. Nalumu, “Improving energy efficiency of HVAC systems in buildings: a review of best practices,” Int. J. Build. Pathol. Adapt., vol. 40, no. 2, pp. 165–182, Jan. 2022, doi: 10.1108/IJBPA-02-2021-0019.
[33] M. Vujanović, Q. Wang, M. Mohsen, N. Duić, and J. Yan, “Recent progress in sustainable energy-efficient technologies and environmental impacts on energy systems,” Appl. Energy, vol. 283, p. 116280, 2021, doi: https://doi.org/10.1016/j.apenergy.2020.116280.
[34] M. van Roosmalen, A. Herrmann, and A. Kumar, “A review of prefabricated self-sufficient facades with integrated decentralised HVAC and renewable energy generation and storage,” Energy Build., vol. 248, p. 111107, 2021, doi: https://doi.org/10.1016/j.enbuild.2021.111107.
[35] C. Name et al., “No 主観的健康感を中心とした在宅高齢者における 健康関連指標に関する共分散構造分析Title,” Pap. Knowl. . Towar. a Media Hist. Doc., vol. 3, no. 2, p. 6, 2021.
[36] K. K. Vivian W. Y. Tam and A. Brohier, “Life-cycle analysis by using the alternative sustainable water innovations in residential dwellings,” Int. J. Constr. Manag., vol. 21, no. 11, pp. 1143–1155, 2021, doi: 10.1080/15623599.2019.1603564.
[37] V. Geetha Varma, “Chapter 6 - Water-efficient technologies for sustainable development,” in Urban Water Crisis and Management, A. L. Srivastav, S. Madhav, A. K. Bhardwaj, and E. Valsami-Jones, Eds., in Current Directions in Water Scarcity Research, vol. 6. Elsevier, 2022, pp. 101–128. doi: https://doi.org/10.1016/B978-0-323-91838-1.00009-9.
[38] S. Stang, M. Khalkhali, M. Petrik, M. Palace, Z. Lu, and W. Mo, “Spatially optimized distribution of household rainwater harvesting and greywater recycling systems,” J. Clean. Prod., vol. 312, p. 127736, 2021, doi: https://doi.org/10.1016/j.jclepro.2021.127736.
[39] H. G. G. A. K. Elif Kucukkaya Alper Kelesoglu and U. Unver, “Design of a passive rainwater harvesting system with green building approach,” Int. J. Sustain. Energy, vol. 40, no. 2, pp. 175–187, 2021, doi: 10.1080/14786451.2020.1801681.
[40] R. Maskwa, K. Gardner, and W. Mo, “A Spatial Life Cycle Cost Comparison of Residential Greywater and Rainwater Harvesting Systems,” Environ. Eng. Sci., vol. 38, no. 8, pp. 715–728, 2021, doi: 10.1089/ees.2020.0426.
[41] A. Alabeed, A. Allaq, H. Hamdi, E. Bashir, and A. Mohammed, “Emerging Drinking Water Borne Diseases : A Review on Types , Sources and Health Precaution,” vol. 35, no. 31, pp. 1–17, 2023, doi: 10.9734/JPRI/2023/v35i317462.
[42] A. El Mezouari, A. El Fazziki, and M. Sadgal, “Smart Irrigation System,” IFAC-PapersOnLine, vol. 55, no. 10, pp. 3298–3303, 2022, doi: 10.1016/j.ifacol.2022.10.125.
[43] J. Chen, “DigitalCommons @ USU Water Conservation Through Drought-Resilient Landscape Plants and Deficit Irrigation b y,” 2023.
[44] V. Divya and A. Umamakeswari, “Smart Irrigation Technique,” vol. 5, no. 1, pp. 385–390, 2013.
[45] S. A. Nnaemeka, D. O. Fadumo, and ..., “Examining the Criteria for the Selection of Green Building Materials in the Construction Industry in Nigeria,” Indiana J. …, no. January, pp. 58–62, 2021, [Online]. Available: https://indianapublications.com/articles/IJHSS_2(7)_58-62cc_61238c8c853fe9.53249696.pdf
[46] W. L. Ng, M. Y. Chin, J. Zhou, K. S. Woon, and A. Y. Ching, “The overlooked criteria in green building certification system: Embodied energy and thermal insulation on non-residential building with a case study in Malaysia,” Energy, vol. 259, p. 124912, 2022, doi: https://doi.org/10.1016/j.energy.2022.124912.
[47] G. Sarpong-Nsiah, A. Acakpovi, and G. K. Aggrey, “A Multi-Criteria Approach for Energetic Expense and Carbon Dioxide Emission Decrease through Locally Sourced and Recycled Building Material Selection: Housing Construction in Ghana,” in 2021 IEEE 8th International Conference on Adaptive Science and Technology (ICAST), 2021, pp. 1–6. doi: 10.1109/ICAST52759.2021.9682000.

[48] M. Rockwell-Postel, B. B. Laginhas, and B. A. Bradley, "Supporting proactive management in the context of climate change: prioritizing range-shifting invasive plants based on impact," Biol. Invasions, vol. 22, no. 7, pp. 2371–2383, 2020, doi: 10.1007/s10530-020-02261-1.
[49] V. Sheikh and R. Izanloo, "Assessment of low impact development stormwater management alternatives in the city of Bojnord, Iran," Urban Water J., vol. 18, no. 6, pp. 449–464, 2021, doi: 10.1080/1573062X.2021.1893364.
[50] A. Rana et al., "A process-based LCA for selection of low-impact DBPs control strategy for indoor swimming pool operation," J. Clean. Prod., vol. 270, p. 122372, 2020, doi: https://doi.org/10.1016/j.jclepro.2020.122372.
[51] R. Liberti, R. Veneziano, and G. Carozza, "Fashion Design Out of Waste: Cradle to Cradle Dress," in Advances in Design, Music and Arts II, D. Raposo, J. Neves, R. Silva, L. Correia Castilho, and R. Dias, Eds., Cham: Springer International Publishing, 2023, pp. 312–327.
[52] M. Y. Khalid, Z. U. Arif, W. Ahmed, and H. Arshad, "Recent trends in recycling and reusing techniques of different plastic polymers and their composite materials," Sustain. Mater. Technol., vol. 31, p. e00382, 2022, doi: https://doi.org/10.1016/j.susmat.2021.e00382.
[53] R. Kumar et al., "Impacts of plastic pollution on ecosystem services, sustainable development goals, and need to focus on circular economy and policy interventions," Sustain., vol. 13, no. 17, pp. 1–40, 2021, doi: 10.3390/su13179963.
[54] K. Kabirifar, M. Mojtahedi, C. Wang, and V. W. Y. Tam, "Construction and demolition waste management contributing factors coupled with reduce, reuse, and recycle strategies for effective waste management: A review," J. Clean. Prod., vol. 263, p. 121265, 2020, doi: https://doi.org/10.1016/j.jclepro.2020.121265.
[55] A. T. W. Yu, I. Wong, Z. Wu, and C. S. Poon, "Strategies for effective waste reduction and management of building construction projects in highly urbanized cities— a case study of hong kong," Buildings, vol. 11, no. 5, pp. 1–14, 2021, doi: 10.3390/buildings11050214.
[56] J. Liu, Y. Yi, and X. Wang, "Exploring factors influencing construction waste reduction: A structural equation modeling approach," J. Clean. Prod., vol. 276, p. 123185, 2020, doi: https://doi.org/10.1016/j.jclepro.2020.123185.
[57] M. S. W. S. A. K. S. P. M. C. L. B. M. M. M. S. R. C. T. Z. G. S. I. M. I. I. A. A. Mark James Whittaker Konstantinos Grigoriadis and A. Largo, "Novel construction and demolition waste (CDW) treatment and uses to maximize reuse and recycling," Adv. Build. Energy Res., vol. 15, no. 2, pp. 253–269, 2021, doi: 10.1080/17512549.2019.1702586.
[58] H. Wang, X. Pan, S. Zhang, and P. Zhang, "Simulation analysis of implementation effects of construction and demolition waste disposal policies," Waste Manag., vol. 126, pp. 684–693, 2021, doi: https://doi.org/10.1016/j.wasman.2021.03.056.
[59] C. P. Ginga, J. M. C. Ongpeng, and M. K. M. Daly, "Circular economy on construction and demolition waste: A literature review on material recovery and production," Materials (Basel)., vol. 13, no. 13, pp. 1–18, 2020, doi: 10.3390/ma13132970.
[60] E. Iacovidou, P. Purnell, K. D. Tsavdaridis, and K. Poologanathan, "Digitally enabled modular construction for promoting modular components reuse: A UK view," J. Build. Eng., vol. 42, p. 102820, 2021, doi: https://doi.org/10.1016/j.jobe.2021.102820.
[61] Z. Wu, L. Luo, H. Li, Y. Wang, G. Bi, and M. F. Antwi-Afari, "An analysis on promoting prefabrication implementation in construction industry towards sustainability," Int. J. Environ. Res. Public Health, vol. 18, no. 21, 2021, doi: 10.3390/ijerph182111493.
[62] Y. Zhang and W. Pan, "Reducing Construction Waste Through Modular Construction," in Proceedings of the 26th International Symposium on Advancement of Construction Management and Real Estate, H. Guo, D. Fang, W. Lu, and Y. Peng, Eds., Singapore: Springer Nature Singapore, 2022, pp. 339–347.
[63] C. Farrell et al., "Can we integrate ecological approaches to improve plant selection for green infrastructure?," Urban For. Urban Green., vol. 76, p. 127732, 2022, doi: https://doi.org/10.1016/j.ufug.2022.127732.
[64] M. A. Coombes and H. A. Viles, "Integrating nature-based solutions and the conservation of urban built heritage: Challenges, opportunities, and prospects," Urban For. Urban Green., vol. 63, p. 127192, 2021, doi: https://doi.org/10.1016/j.ufug.2021.127192.
[65] A. Diener and P. Mudu, "How can vegetation protect us from air pollution? A critical review on green spaces' mitigation abilities for air-borne particles from a public health perspective - with implications for urban planning," Sci. Total Environ., vol. 796, p. 148605, 2021, doi: https://doi.org/10.1016/j.scitotenv.2021.148605.
[66] A. S. El Menshawy, A. F. Mohamed, and N. M. Fathy, "A comparative study on green wall construction systems, case study: South valley campus of AASTMT," Case Stud. Constr. Mater., vol. 16, p. e00808, 2022, doi: https://doi.org/10.1016/j.cscm.2021.e00808.
[67] H. Y. Liu, M. Jay, and X. Chen, "The role of nature-based solutions for improving environmental quality, health and well-being," Sustain., vol. 13, no. 19, pp. 1–56, 2021, doi: 10.3390/su131910950.
[68] S. Pragati, R. Shanthi Priya, C. Pradeepa, and R. Senthil, "Simulation of the Energy Performance of a Building with Green Roofs and Green Walls in a Tropical Climate," Sustain., vol. 15, no. 3, 2023, doi: 10.3390/su15032006.
[69] A. M. Elsaid and M. S. Ahmed, "Indoor Air Quality Strategies for Air-Conditioning and Ventilation Systems with the Spread of the Global Coronavirus (COVID-19) Epidemic: Improvements and Recommendations," Environ. Res., vol. 199, p. 111314, 2021, doi: https://doi.org/10.1016/j.envres.2021.111314.
[70] J. Saini, M. Dutta, and G. Marques, "A comprehensive review on indoor air quality monitoring systems for enhanced public health," Sustain. Environ. Res., vol. 30, no. 1, p. 6, 2020, doi: 10.1186/s42834-020-0047-y.

[71] G. Marques, J. Saini, M. Dutta, P. K. Singh, and W. C. Hong, “Indoor air quality monitoring systems for enhanced living environments: A review toward sustainable smart cities,” Sustain., vol. 12, no. 10, 2020, doi: 10.3390/SU12104024.
[72] J. Jeon, J. H. Park, S. Wi, B. Y. Yun, T. Kim, and S. Kim, “Field study on the improvement of indoor air quality with toluene adsorption finishing materials in an urban residential apartment,” Environ. Pollut., vol. 261, p. 114137, 2020, doi: https://doi.org/10.1016/j.envpol.2020.114137.
[73] A. S. dos Reis, M. F. Dias, and A. Tavares, “Filling the Health Gap in Energy Performance Certificates to Reduce Pulmonary Diseases Due to Bad Indoor Air Quality,” in Environmental Restoration, D. K. Ashish and J. de Brito, Eds., Cham: Springer International Publishing, 2022, pp. 259–275.
[74] M. Arar and C. Jung, “Improving the indoor air quality in nursery buildings in United Arab Emirates,” Int. J. Environ. Res. Public Health, vol. 18, no. 22, 2021, doi: 10.3390/ijerph182212091.
[75] A.-M. Sadick and I. Kamardeen, “Enhancing employees’ performance and well-being with nature exposure embedded office workplace design,” J. Build. Eng., vol. 32, p. 101789, 2020, doi: https://doi.org/10.1016/j.jobe.2020.101789.
[76] A. Fnais et al., “The application of life cycle assessment in buildings: challenges, and directions for future research,” Int. J. Life Cycle Assess., vol. 27, no. 5, pp. 627–654, 2022, doi: 10.1007/s11367-022-02058-5.
[77] J. A. Mesa, C. E. Fúquene, and A. Maury-Ramírez, “Life cycle assessment on construction and demolition waste: A systematic literature review,” Sustain., vol. 13, no. 14, 2021, doi: 10.3390/su13147676.
[78] J. G. Backes and M. Traverso, “Application of life cycle sustainability assessment in the construction sector: A systematic literature review,” Processes, vol. 9, no. 7, 2021, doi: 10.3390/pr9071248.
[79] H. Amini Toosi, M. Lavagna, F. Leonforte, C. Del Pero, and N. Aste, “Life Cycle Sustainability Assessment in Building Energy Retrofitting; A Review,” Sustain. Cities Soc., vol. 60, p. 102248, 2020, doi: https://doi.org/10.1016/j.scs.2020.102248.
[80] Hasan, R. A., Alhayali, R. A. I., Mohammed, M. A., & Sutikno, T. (2022). An improved fish swarm algorithm to assign tasks and cut down on latency in cloud computing. TELKOMNIKA (Telecommunication Computing Electronics and Control), 20(5), 1103-1108.
[81] R. A. Hasan, H. W. Abdulwahid, and A. S. Abdalzahra, “Using Ideal Time Horizon for Energy Cost Determination,” Iraqi Journal for Computer Science and Mathematics, pp. 9–13, 2021, doi: 10.52866/ijcsm.2021.02.01.002.
[82] Ali, A. H., Mohammed, M. A., Hasan, R. A., Abbod, M. N., Ahmed, M. S., & Sutikno, T. (2023). Big data classification based on improved parallel k-nearest neighbor. TELKOMNIKA (Telecommunication Computing Electronics and Control), 21(1), 235-246.
[83] Mohammed, M. A., Akawee, M. M., Saleh, Z. H., Hasan, R. A., Ali, A. H., & Sutikno, T. (2023). The effectiveness of big data classification control based on principal component analysis. Bulletin of Electrical Engineering and Informatics, 12(1), 427-434.
[84] H. Lei, L. Li, W. Yang, Y. Bian, and C.-Q. Li, “An analytical review on application of life cycle assessment in circular economy for built environment,” J. Build. Eng., vol. 44, p. 103374, 2021, doi: https://doi.org/10.1016/j.jobe.2021.103374.
[85] C. Vandervaeren, W. Galle, A. Stephan, and N. De Temmerman, “More than the sum of its parts: Considering interdependencies in the life cycle material flow and environmental assessment of demountable buildings,” Resour. Conserv. Recycl., vol. 177, p. 106001, 2022, doi: https://doi.org/10.1016/j.resconrec.2021.106001.
[86] M. A. Pellow, H. Ambrose, D. Mulvaney, R. Betita, and S. Shaw, “Research gaps in environmental life cycle assessments of lithium ion batteries for grid-scale stationary energy storage systems: End-of-life options and other issues,” Sustain. Mater. Technol., vol. 23, p. e00120, 2020, doi: https://doi.org/10.1016/j.susmat.2019.e00120.
[87] S. I. Jasim, M. M. Akawee, and R. A. Hasan, "A spectrum sensing approaches in cognitive radio network by using cloud computing environment," *Bulletin of Electrical Engineering and Informatics*, vol. 11, no. 2, pp. 750–757, 2022.
[88] R. A. Hasan, M. N. Mohammed, M. A. B. Ameedeen, and E. T. Khalaf, "Dynamic load balancing model based on server status (DLBS) for green computing," *Advanced Science Letters*, vol. 24, no. 10, pp. 7777–7782, 2018.